

Beijing China
October 26, 1976

Beijing China
May 16, 1991

U. S. Geological Survey Mission

As the Nation's largest earth-science research and information agency, the USGS maintains a long tradition of providing "Earth Science in the Public Service."

The USGS, a bureau of the U.S. Department of the Interior, was established to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain."

As a Nation we face serious questions concerning our global environment. Will we have adequate supplies of quality water available for national needs? How can we ensure an adequate supply of critical water, energy, and mineral resources in the future? In what ways are we irreversibly altering our natural environment when we use these resources? How has the global environment changed over geologic time, and what can the past tell us about the future? How can we predict, prevent and mitigate the effects of natural hazards?

Collecting, analyzing, and disseminating the scientific information needed to answer these questions are the primary mission of the USGS. This information is provided to the public in many forms, such as reports, maps and data bases, that provide descriptions and analyses of the water, energy, and mineral resources, the land surface, the underlying geologic structure, and the dynamic processes of the Earth.

The EROS Data Center Vision

“We are stewards of land remote sensing and associated data, advancing the availability and applicability of these data for scientific and land management users worldwide.”

The Mission of the EROS Data Center

The fundamental mission of the U. S. Geological Survey’s EROS Data Center is to contribute to meeting the Nation’s needs for basic geographic, cartographic, and other types of earth-science information by acquiring, managing, and distributing land remote sensing and associated spatial data. In support of this mission we:

- *Provide data products and services to scientific and land management users worldwide.*
- *Develop, implement, and operate advanced data storage, information management, data processing, product generation, and product delivery systems.*
- *Define and document user requirements, conduct research, and develop data and related technology applications.*

Foreword

We at the U.S. Geological Survey's EROS Data Center have the same job we started with more than two decades ago. We supply data – the raw material of science – to a worldwide community of users who need us and our products more desperately all the time. The USGS prides itself in “earth science in the public service.” All science begins with careful observation, with data meticulously collected. Only when the data are in, organized, and available, and the applications of the data are understood, can the adventure of science proceed. Our job, then, as the Earth Resources Observation Systems Data Center, is fundamental to expanding knowledge of the planet itself.

In the face of budget cuts and dubious public support for Government in general, I am proud to report that we continue to progress in many areas. I measure these achievements in the only meaningful terms: our ability to supply data to the people who need data in the interest of resource management, environmental assessment, and the study of earth science. Internal considerations aside, we work for a set of customers who find our products and services more useful and access to them easier than they did a year ago. This report documents that assertion, particularly in the sections dealing with increasing access to online data products.

I present the EROS Data Center's annual report for fiscal year 1995 with pride in our employees, satisfaction in their achievements, and confidence in our ability to respond creatively to challenges which continue to mount.

*Donald T. Lauer
Chief, EROS Data Center*

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Cover

Landsat multispectral scanner images, acquired October 26, 1976, and May 16, 1991, show the increasing urban development in the Beijing, China region.

The development of urban areas at the expense of agricultural regions are evident as the red (vegetation) tones are replaced by blue (urban units). Several easily recognizable features are visible. The Forbidden City (Imperial Palace Museum) is outlined by the walls to the right of Zhong Hai Lake in the center of the city. The Temple of Heaven Park is the reddish area (darker than the agricultural vegetation) below and slightly right of the Forbidden City and just above the canal in the lower portion of the city. Kunming Hu Lake, immediately above and to the left of the city and adjacent to the mountains, includes the historic Summer Palace. The Capital airport is the large runway complex above and to the right of the city.

EROS Data Center Overview

The Earth Resources Observation Systems (EROS) Data Center (EDC) is a field center for many programs and activities of the U.S. Geological Survey's National Mapping Division (NMD). Located near Sioux Falls, South Dakota, the EROS Data Center manages earth-science data bases, develops computer systems, and shares technical expertise with users from Missouri to Madagascar. The United States Department of the Interior established the Center in 1971 to receive, process, and distribute data from Landsat satellites - a series of experimental platforms launched by the National Aeronautics and Space Administration (NASA). Two decades later, Congress mandated the EDC to become the National Satellite Land Remote Sensing Data Archive. This legislative mandate directs EROS to maintain a high-quality data base of images of the Earth acquired from space suitable to study global environmental change. As a result, EDC holds the world's largest collection of images of the Earth acquired by spacecraft and aircraft. These holdings include over 10.6 million frames of photographic data and over 197,000 digital tapes. The EROS Data Center also is a major information source for the holdings of foreign Landsat ground reception stations and data acquired by other nations' Earth observing satellites. In addition to these data holdings, EDC receives and processes image data from the Advanced Very High Resolution Radiometer (AVHRR) aboard National Oceanic and Atmospheric Administration (NOAA) weather satellites.

The Data Center's mission centers around activities associated with managing many types and large volumes of global Earth observations data. Its mission includes, but is not limited to, developing and operating advanced computer systems to receive, process, and distribute earth-science data. These and other map and geographic data support many types of scientific studies, resource management, and environmental monitoring activities worldwide. At the Center, Earth scientists from many disciplines combine expertise with engineers, technicians, and professionals in systems development, telecommunications, and computer science to conduct research and develop applications that support the mission of the U.S. Geological Survey.

Another key part of the Center's mission is its involvement in NASA's "Mission to Planet Earth" program. Because of its tie to NASA, EDC will process and archive land data acquired by sensors aboard the Earth Observing System (EOS) satellites, the first of which will be launched in the late 1990s. The Center continues to assume a major role in managing and distributing remotely sensed land data used by global environmental change researchers. This role is strengthened by EDC's capacity as the Earth Observing System Data and Information System (EOSDIS) Land Processes Distributive Active Archive Center (LPDAAC).

Under another joint partnership with NASA, the Data Center also serves as the home and primary source for data for the United Nations Environmental Programme/Global Resource Information Database (UNEP/GRID) North America Node office. This office is one of several worldwide forming a network to distributed data and research techniques for timely environmental studies by member nations.

In addition to in-house facilities, the Data Center operates field offices or assigns scientists to sites in Anchorage, Alaska, Greenbelt, Maryland, Reston, Virginia, Mountain View, California, and Harare, Zimbabwe to support resource and environmental studies in those locations.

A Highlight Report – The EDC Building Addition

Construction continued in FY 95 on a major addition to the Center's facility. This addition is designed to support the long-standing partnership between the USGS and NASA. It will serve both the Earth Observing System (EOS) and Landsat missions as they evolve in the next decade. It also offers the USGS opportunities for cooperative programs and expanded access to space based data for research. The addition will house high performance computer systems, advanced telecommunications networks and skilled personnel required to process and distribute EOS and Landsat data. These data will be used by researchers to study the Earth as an integrated system and by others to map the extent and distribution of natural resources, monitor land surface changes, and assess environmental conditions. Construction began in June of 1994 and is now scheduled for completion in March of 1996. (figure 1)

By the end of FY 1995 the addition was fully enclosed, exterior landscaping was largely complete, and the interior was the scene of intense activity. The computer room was enclosed and the raised floor installed above an extensive grounding and signal reference grid. Interior offices, communications rooms, meeting rooms and facility support spaces were taking shape. Fan systems and heating, ventilation and air conditioning equipment were installed. Placement of electrical security and building management systems was underway. Installation of communications cabling to provide the necessary voice and data network was initiated. At the end of FY 1995 the construction was on or ahead of schedule.

National Satellite Land Remote Sensing Data Archive (NSLRSDA)

The EDC has managed the Landsat data archive, a rich collection of information of the Earth's land surface, for more than two decades. Major changes on the surface of the planet can be detected and analyzed using data from sensors aboard the Landsat series of satellites. Examples of observable phenomena include the effects of desertification, deforestation, some kinds of environmental pollution, and cataclysmic volcanic activity. Comparisons of historical and current Landsat data play a key role in detecting surface changes through time.

These kinds of analyses emphasize the importance of preserving and ensuring long-term access to Landsat and other land remote sensing satellite data. That importance was officially recognized in the Land Remote Sensing Policy Act of 1992, Public Law 102-555, passed Oct. 28, 1992. The Act directs the Department of the Interior (DOI) to establish and manage a National Satellite Land Remote Sensing Data Archive, responsibility for which has been delegated to the USGS's EROS Data Center. The Archive, as defined by the law, provides for the preservation of and access to satellite-acquired land remote sensing data, with related research activity.

While Landsat data are the largest single element of the Archive, other land

satellite or data are also important parts of the collection. The Archive includes all U.S. held data from Landsat satellites 1 through 5: advanced very high resolution radiometer (AVHRR) data; declassified intelligence satellite photographs; and Gemini and Apollo, Skylab, and Space Shuttle data now held at the EDC. The Archive also will include all Earth Observing System land processes data acquired by NASA, all Landsat 7 data to be acquired by the government, and other satellite land data such as the French SPOT program.

The EDC recently issued a new edition of Historical Landsat Data Comparisons-Illustrations of the Earth's Changing Surface. This color booklet, in simple language, documents some of the changes, both natural and anthropogenic, on the Earth's surface of the past 20 years. Landsat multispectral scanner (MSS) and thematic mapper (TM) data sets were used to illustrate changes such as the oil fires in Kuwait, the eruption of Mount St. Helens, diminution of a Brazilian tropic rainforest, and the effects on the Aral Sea of intensive irrigation using its waters. The booklet also includes an overview of the Landsat program.

Landsat Operations

Landsat 4 has been in standby mode since August of 1993, but Landsat 5 continues to operate nominally, acquiring TM data and downlinking through X-band transmission only. Both spacecraft have lost tracking and data relay satellite system communication. Landsat Program Management (LPM) and EOSAT, the commercial operator of the Landsat satellite system data, reached agreement in April 1994 on provisions for Landsat 4 and 5 operations until the demise of the satellite. The LPM Agreement was incorporated into the Department of Commerce's contract with EOSAT in June 1995.

The LPM Agreement establishes the government and its affiliated user (USGAU) purchaser group with EOSAT. The USGAU has unrestricted rights to reproduce and redistribute, among its own members, all unenhanced Landsat TM data purchased by the USGAU for noncommercial use.

The USGAU includes federal agencies and contractor researchers involved with the U.S. global change research program and its international counterpart programs, and other researchers and international entities that have signed agreements with the government involving the noncommercial use of Landsat data.

Data Management

Landsat Data Conversion and Maintenance

Public law requires the government to maintain Landsat data for long-term scientific study. The EDC therefore continues to transfer all U.S. Landsat data to a new storage medium, digital cassette recording system-incremental, or DCRSi.

Multispectral scanner (MSS) data acquired between 1979 and 1992 have been converted. The thematic mapper (TM) data conversion started in November 1993 and as of October 1, 1995, 14,000 high-density tapes containing 225,000 scenes had been copied to 1,400 digital cassette tapes. As a result of converting



Figure 1

these tapes, more than 68,000 scenes previously unprocessed and not catalogued, were processed, inspected and catalogued.

MacDonald Dettwiler and Associates (MDA) installed a VAX-based TM processing system to satisfy customer requests for systematic and precision registered data until the National Landsat Production System (NLAPS) was delivered by MDA in October 1995. This system, known as the Geocoded Image Correction System (GICS) was used to distribute products to both public and Federal users starting in January 1995. These were the first digital data processed and distributed from high-density DCRSi. Since January 1995, production has grown steadily to an average of more than 100 products monthly at the end of fiscal year. Year-to-date statistics included:

TM Data Production

	YTD
Bulk Corrected.....	1
Precision Geocoded	63
Precision Georeferenced	1
Systematic Geocoded.....	220
Systematic Georeferenced	426
Total	711

The U.S. government announced February 24, 1995, its plans to declassify satellite photographs collected during the 1960's and early 1970's. The USGS coordinated the World Wide Web release of historical background information and samples of these photographs with overwhelming response from the public. Access to the World Wide Web pages describing these data saturated the USGS high-volume Internet network line within 2 hours and the public maintained a high plateau of access for the remaining seven months of FY 1995 (figure 2).

Declassified Intelligence Satellite Photographs

The EDC continues to receive AVHRR data via direct reception, network transfer, DOMSAT relay and tape transfer from 31 receiving stations around the world. There are currently over 110,000 AVHRR scenes referenced in the database inventory including 7,550 combined orbital passes. The orbital passes, within track stitching of individual AVHRR scenes, are being generated in support to the NASA Mission to Planet Earth Program (MTPE) and the USGS Land Characterization Program. All AVHRR metadata and browse information are available through the USGS Global Land Information System (GLIS).

AVHRR Data Management

The EDC continued to produce comprehensive time series data sets of vegetation greenness condition. These products are useful for monitoring vegetation condition in forest, agricultural, and grassland ecosystems. Annually, EDC produces 31 greenness products. These include:

Greenness Mapping Production

- 16 biweekly periods over the conterminous United States.
- Nine, 10-day periods covering parts of eastern Europe and Central Asia for June through August.
- Six, 15-day periods covering the Middle East for March through June.

The greenness products are distributed on CD-ROM, electronically, and on magnetic tape.

*Satellite Data
Search and Order
Services*

Following the commercialization of the Landsat system in 1984, the USGS established a purchasing agreement to assist federal agencies in obtaining Landsat products and services from EOSAT, the commercial operator of the Landsat satellite system. In 1987, a similar agreement was established with SPOT Image Corp., the exclusive distributor of the French Satellite Pour l'Observation de la Terre data in the United States. In 1995, India satellite data were added to the EOSAT purchasing agreement. These purchasing agreements eliminated the need for each Federal agency to establish and administer separate agreements for the purchase of civilian satellite data and established a mechanism for each federal agency to issue a single purchase order for Landsat, India, and SPOT products and services. While the use of these agreements is optional, since 1985, 30 Federal agencies have purchased more than \$36 million worth of data through these agreements, with \$4 million purchased in FY 1995.

Land Processes Distributed Active Archive Center (LPDAAC)

The USGS is cooperating with NASA in efforts to acquire, archive, process, and distribute remotely sensed land observations collected under the auspices of NASA's Mission To Planet Earth Program. The EDC has been designated a Distributed Active Archive Center (DAAC) for the Mission to Planet Earth program, with responsibility for archiving and distributing land processes data from the Earth Observing System, Landsat 7, and other land observing satellites. To carry out this role, the EDC was required to significantly augment existing facilities.

EDC staff are currently participating in intensive design and engineering activities required to implement systems to archive and distribute these data as soon as possible after spacecraft launches occur in mid-1998. However, other activities are also underway to provide improved data products, as precursor data sets to future missions, from existing data archives and operational satellite platforms.

*Global Land 1km
AVHRR Data Set
Project*

Throughout fiscal 1995, the Global Land 1km AVHRR data set project team continued to devote extensive effort to refining processing systems and procedures in order to provide the best possible data products from the global 1 km AVHRR data archive. By the end of fiscal 1995, the project had produced seven 10-day global vegetation index composites, 36 North America composites, and 21 South America composites.

*Digital Elevation
Model Development*

The EDC DAAC topographic data set development project is key to development of improved digital elevation data of the land masses of the world to support at-launch requirements of the Earth Observing System (EOS). Acting upon the recommendation of the EOS at-launch Digital Elevation Model (DEM) working group, the EDC DAAC accepted leadership in early 1995 of a project to ensure development of a global 30-arc-second DEM data set. A 30-arc-second DEM of Africa was released in September. In April, a 30-arc-second DEM of

Declassified Imagery Inquiries

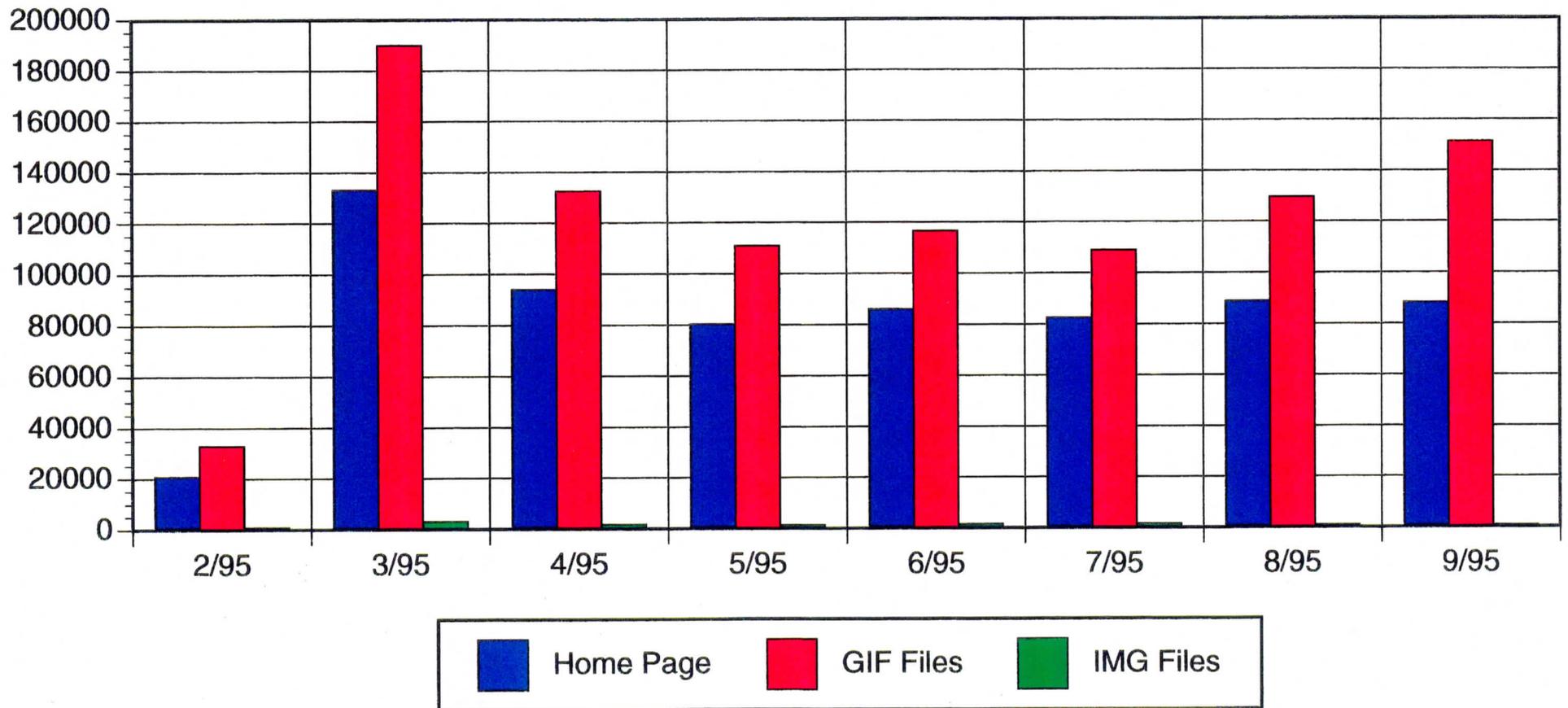


Figure 2

North America (figure 3) was completed and staged for network access. Work is underway on the South American, European, and Asian DEM's. The primary source data for these products is a data set generalized from the digital terrain elevation data (DTED) from the Defense Mapping Agency. Additional data from a number of international organizations are augmented by gridding the Digital Chart of the World contours, point elevations, and hydrology; and blending the grid from the DCW with the grid from the generalized DTED. The goal is to complete a global land mass 1km (30-arc-second) DEM data set in 1996.

The collection of Shuttle Imaging Radar-C (SIR-C) data in the EDC DAAC grew significantly in 1995 following the second SIR-C mission in October 1994. By the end of the fiscal year, the EDC DAAC had received more than 50 sets of CD-ROM's containing lower resolution "survey" data from the first mission and an additional 60 sets from the second mission. In addition to providing copies of these CD-ROM's upon request, all SIR-C survey images are also available online through a SIR-C World Wide Web interface.

Shuttle Imaging Radar Data

In January, the DAAC began receiving the higher resolution, processed, SIR-C "precision" data. A catalog of available SIR-C precision data, available through the DAAC World Wide Web home page, was released to the public in July. In addition to the survey and precision data, more than 3,000 copies of the SIR-C educational CD-ROM were distributed, containing examples of radar imagery, including recent SIR-C data, geared primarily toward educators.

The EDC DAAC Data Distribution System was completed in February 1995. Designed to serve as the near-line repository of those DAAC data sets being made available through the Internet, the system includes a Silicon Graphics Challenge XL computer, a Digital Linear Tape (DLT) robotic data storage system, and AMASS mass storage system software. It can hold up to 2.4 terabytes of data.

EDC DAAC Data Distribution System

The system has been populated with Global Land 1km AVHRR orbital segment and global composite products, SIR-C survey data, and 30-arc-second DEM's created from the DAAC projects described above. For example, each 10-day global 1 KM AVHRR composite represents about 10 gigabytes of data. Through the project's home page, users can ask for data at full 1km resolution or at lower resolutions of 2, 4, 8, or 16 km.

In addition to the continued expansion of these data sets, other data sets to be added to the system include Global Land Cover Test Site, Humid Tropical Forest, and other Landsat Pathfinder products. In fiscal 1995, more than 98 gigabytes of data were distributed to users through the network from the EDC DAAC.

While production operations were focused on producing and distributing data products from existing, pre-EOS data sources, systems engineering and development work has proceeded rapidly. This work focused on the design and development of the data and information system to be implemented in 1998 to support EOS and Landsat spacecraft missions that will begin to acquire data

Earth Observing System Data and Information System

in mid-1998. EDC staff participated extensively in review meetings to validate system requirements, to review system design constraints, to participate in system prototyping activities, and to work toward definition of operations concepts and system integration and test plans.

Landsat 7 Systems Engineering

The Landsat 7 project placed extensive demands on EDC resources in 1995. The Center is responsible for system integration and test of the Landsat 7 ground station (a tracking antenna and associated electronics) and the Landsat processing system (a processing system composed of five independent, complementary strings of computer equipment). These system components are required to receive Landsat data from the spacecraft, process the data to a level acceptable for archiving, and pass the data on to the DAAC for archiving and product distribution. EDC staff continued to support the requirements definition, system design, and operational planning activities required to successfully implement these system components.

In addition, as the receiving and processing facility for these data, the EDC also must assume responsibility for quality assurance of the data going into the archive, as well as the quality of the product delivered to users from the archive. Therefore, the EDC assumed responsibility for designing and developing a major system element called the Image Assessment System. The major 1995 activity was to assist, in cooperation with NASA, in completing the system requirements review to ensure that system design activity could proceed in 1996.

Advanced Systems Engineering

Technology initiatives were pursued in two specific areas in 1995. A new initiative was fostered when the EDC was invited to participate in planning meetings to prepare for archiving and distributing data from two NASA technology experimental, spacecraft, named Lewis and Clark. Through these planning meetings, agreement was reached that the resulting data archives, once validated for quality by NASA, would be transferred to the EDC DAAC for preservation and distribution of related products.

The second technology investigation involved continuation of work initiated in previous years to prototype applications of high speed computing and communications by demonstrating the ability to deliver large data sets to high - volume users over national high speed networks. This work is sponsored by the Defense Advanced Research Projects Agency, NASA, and the USGS, and explores the use of Asynchronous Transfer Mode (ATM) networking technology to investigate the "real-world" problems encountered in distributing large data sets via advanced telecommunications networks. The key accomplishments in 1995 were the establishment of a high-speed network link from the EDC to the experimental ATM network currently being tested in the Washington D.C. area, and the development of a suite of data staging algorithms to allow rapid staging of large data sets from internal data archives to a pick-up point for network transmission. The initial benefit of this investigation is the planned implementation in 1996 of a reliable network link from the EDC to the NASA Goddard Space Flight Center in Greenbelt, Maryland.

The U.S. GeoData Sales Data Base component of the National Digital Cartographic Data Base (NDCDB) completed a full year of operation in June 1995.

*The National Digital
Cartographic Data
Base (NDCDB)
Sales Data Base*

This online data source comprises both an automated catalog based on graphic maps and the online data files themselves. Customer response has been substantial and favorable to the full set of cartographic data on media, including compact disc-recordable beginning early in the fiscal year. In fiscal year 1995, sales of digital cartographic data rose by 475 percent over the previous year.

A major milestone for the NDCDB was the development and release of the national spatial data infrastructure query capability that allows customers to search for USGS data sets using the World Wide Web and receive information about these data in Federal Geographic Data Committee compliant format. This National Spatial Data Infrastructure tool has already been expanded to support not only the NDCDB, but the satellite inventories maintained by EDC as well.

Internet World Wide Web access to USGS GeoData products has also completed its first full year of operation. Those Geodata files in the federal government standard format are available to self-service Internet customers at no charge. Products downloaded by these customers who required no assistance from USGS staff totaled 1.1 million in fiscal 1995 (figure 4). Customers who needed assistance in acquiring these data online paid the cost of this service and downloaded over 4,400 products over the Internet.

*Internet World Wide
Web*

The Global Land Information System (GLIS), an online directory of data sets maintained by the EDC, underwent two key enhancements in fiscal 1995. The first was the addition of geographically searchable catalogs and automated ordering capability for digital USGS cartographic and topographic data sets. This new capability allows USGS customers to use the Internet to search and place their own orders for USGS data and have those orders automatically processed with little assistance from EDC staff.

*Global Land
Information System*

The second GLIS enhancement, resulting from a customer query, was the addition of more detailed base maps upon which geographic coverage is plotted for each product. This additional detail makes it easier for customers to determine whether products are available covering the geographic areas in which they are interested. GLIS use in fiscal 1995 grew steadily from 2,700 to more than 4,000 data searches each month.

National Map and Digital Data Production

Diapositive production

The EDC's production of diapositives – master transparencies of aerial photographs, used principally in mapmaking – increased dramatically in fiscal 1995 because of the growth of the USGS digital orthophotoquad (DOQ) program. Production for the DOQ program doubled, in fact, from the previous year, to a total of 161,400 frames – 90,500 diapositives and 70,900 paper prints. The FY 1996 production is expected to approach 200,000 frames. Scanning to produce the final, digital image is not done from original film, but from the diapositives.

A portion of the original National Aerial Photography Program's (NAPP) collection is at the U. S. Forest Service's Aerial Photography Field Office (APFO) in Salt Lake City, Utah, and the APFO accounted for 27 percent of the 1995 production. The APFO is expected to take over 50 percent of this workload in fiscal 1996.

The NAPP program has produced principally black-and-white photo products, but color diapositives for DOQ's were produced for the first time in 1995 and amounted to 7 percent of production. Color DOQ's, all of which are produced at the APFO, are expected to account for 20 percent of the FY 1996 workload.

Equipment and personnel resources for diapositive production were increased. Two full-time employees were added to the printing staff of four, and a black-and-white processor from the Western Mapping Center was installed to double processing capacity. An additional electronic photo controls printer also was purchased, bringing the printer total to four.

NAPP contracting

EDC photographic engineering staff studied a problem, flight line syndrome, which had been appearing in some NAPP original photography. Their study was chosen for presentation at the Kodak Aerial Photographic Seminar in Rochester, NY.

The problem, caused by drying in the top layer of film emulsion, results in a loss of sensitivity in the infrared layer of color. The subject received considerable attention from the interagency NAPP Steering Committee and contractors. The solicitation for 1996 bids for NAPP work was modified to provide for rejection of film with this problem.

GLOBE program

The EDC assisted in the Global Learning and Observations to Benefit the Environment (GLOBE) program by helping to produce 2,000 remote sensing data sets for use in schools.

GLOBE, initiated by the Vice President of the United States and sponsored chiefly by the National Oceanic and Atmospheric Administration, has grown to a worldwide network of students working under GLOBE-trained teachers to make

EDC Network Product Distribution NDCDB

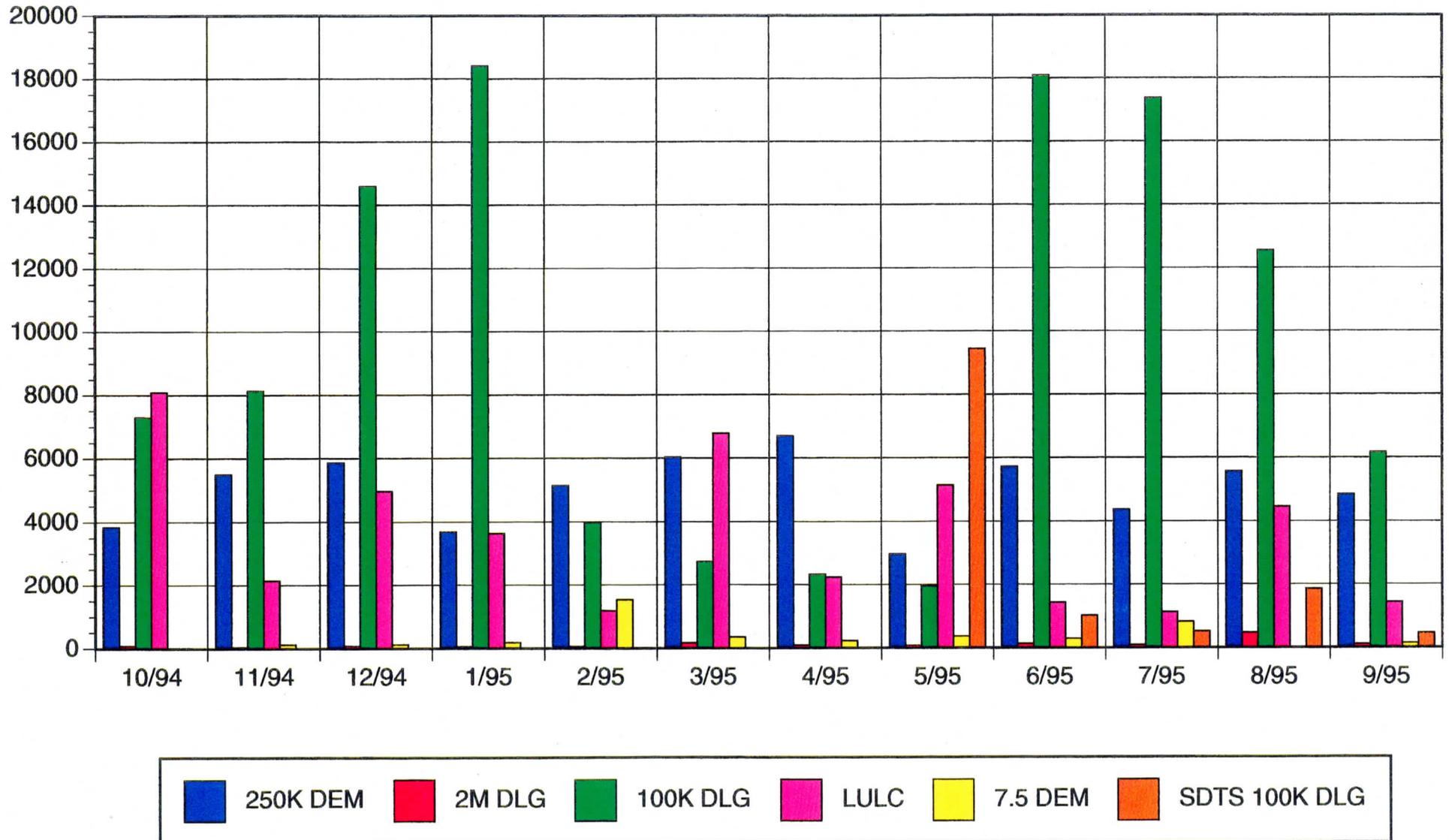


Figure 4

scientific observations near their school. EDC's role is to produce satellite data for selected schools as a prototype. Examples of data produced for selected schools includes the "greenness" data for the lower 48 states, the AVHRR companion data set, thematic mapper data, and digital elevation models. Each data set was centered over one of 120 schools and was assembled and produced on CD-ROM's.

Vector DLG-F Development

Software required to convert 1:100,000-scale USGS digital line graph (DLG) data to DLG-feature (DLG-F) was delivered, and EDC staff worked with the Mapping Application Center in Reston, VA, using it for conversion of hydrography data. More than 3.7 million hydrography features have been converted, covering the lower 48 states, Hawaii, Puerto Rico, and the Virgin Islands.

The hydrography features have been transferred to the EPA, a partner with the USGS in producing and maintaining these data. These features will be returned to the USGS with substantial value-added information, and then be ready for public distribution. These data will have the combined strengths of the USGS DLG data and the EPA River Reach data. The resulting features will be seamless rather than quadrangle-based, having geometric accuracy of the 1:100,000-scale data, include 'names' of hydrography features (i.e., Missouri River), as well as up-stream and down-stream hydrographic flow relationships.

The USGS and Bureau of the Census completed a second transportation development and data production prototype. Transportation data for several counties were revised by the Rocky Mountain Mapping Center (RMMC) using DLG-F software and digital orthophotoquads (DOQ). When the revisions were completed, the data were returned to the Census Bureau to incorporate into a copy of Census' topologically integrated, geographically encoded reference, or TIGER, data base. Several refinements were identified and software for transportation revision production was delivered to the RMMC, facilitating a transition with the Census Bureau into production.

The version 2.0 Digital Standards Data Base was released. This version can be used to describe any number of products that the NMD chooses to support using DLG-F. This data base is integrally linked with the production and feature data base software to manage data that are produced and stored in the data base. The transition of this version into use across the NMD is expected to take several months.

The cooperative research and development agreement, or CRADA, with the Environmental Research Systems Institute (ESRI) of Redlands, CA, has proven beneficial to both ESRI, a private firm, and to the USGS. The efforts have focused primarily on the joint development of a seamless feature data base and digital standards data base, or data dictionary.

The principal benefits to the USGS through this agreement are: a reduction in effort needed to develop the seamless feature data base through use of commercial software, the ability to influence the software engineering development of that commercial software, greater operational flexibility to support working in varying units of coverage during production to provide hydrographic cataloging units to the EPA, counties to the Bureau of the Census, and townships to the Bureau of Land Management. Historically, the NMD has been limited to working in predefined quadrangle units.

ESRI benefits through application of their commercial software to a relatively unique problem, that of nationwide mapping responsibilities. ESRI has also decided to incorporate a data dictionary into their commercial products. They recognized that the Digital Standards Data Base was unique and had succeeded and accomplished much of what they wanted in a data dictionary. ESRI personnel traveled to the EDC to learn about the requirements, design, and implementation of the Digital Standards Data Base. ESRI also gained an understanding of the techniques used to integrally link the Digital Standards Data Base with the production software.

Research and Applications

Researchers at the EDC conduct a variety of projects to develop and test advanced technologies required by the earth-science community in its pursuit of a better understanding of global change and new tools for geographic and spatial information analyses. These projects are supported by USGS research funds, as well as by cooperative agreements with other government organizations.

Global Change Research

Terrain Data Development and Analysis

The digital elevation datasets of continental land masses that are being assembled at the EDC are being further processed to extract additional information that will be broadly used by the scientific and resource management communities including global change, hydrologic modeling, resource monitoring and modeling applications. The work is being done in collaboration with the UNEP/GRID office located at the EDC.

In addition to the traditional slope, aspect, and shaded-relief information that can be derived from digital elevation data, hydrologic information can be extracted by using geographic information system techniques to delineate stream lines and basin boundaries in a digital form. When integrated with other spatial digital information such as soils, land cover, and climate variables, the resultant databases can be used to assess, model, and predict land surface conditions such as erosion, land cover change, vegetation conditions, and flood impact.

In June, 1995, the UNEP/GRID and the EDC held a meeting of international hydrologic modeling experts to seek expert advice and collaboration in the systematic assembly of a global database of basin boundaries. Following the recommendations of the group, the first continental data set processed was North America. (figure 5) The underlying database may be manipulated within a geographic information system to break the basins down into 10,000 square kilometer sub-units. Watershed boundaries were verified with USGS, Canadian and Mexican map sources and collaborators. The African continent is now being processed. Both the DEM and basin delineation were completed for North America.

The Multi-Resolution Land Characterization (MRLC) project is a consortium of cooperators who need land cover characteristics data for their environmental assessment and land management programs. MRLC has three objectives, each designed to meet the needs of a particular set of program and science issues. These objectives are: (1) develop a global one-kilometer land cover characteristics data base; (2) develop regional 30-meter land cover characteristics data bases of the continental U.S., and (3) develop a multi-resolution monitoring system that permits the targeting and assessment of land cover changes.

*Multi-Resolution
Land
Characterization*

The North America one-kilometer AVHRR Normalized Difference Vegetation Index (NDVI) composites were classified into 226 seasonal land cover regions (figure 6) with translations to 5 different land cover legends including USGS Anderson, International Geosphere-Biosphere Programme Global Land Cover, the Simple Biosphere Model, the Biosphere-Atmosphere Transfer Scheme, and the Olson Global Ecosystems legend. These derived data sets were developed through partnerships with the International Geosphere-Biosphere Programme, Environment Canada, University of Nebraska at Lincoln and the Institute of Geography at the Autonomous University of Mexico.

In FY 1995, the U.S. Forest Service officially joined the other MRLC cooperators. The production of a national Landsat TM data base to support USGS National Water Quality Assessment Program (NAWQA), GAP, EMAP, and C-CAP is nearly complete. Five hundred and thirty of the five hundred and eighty Landsat TM scenes have been pre-processed, georeferenced, and clustered. The processed scenes are being delivered to each cooperator where the data are being classified into the land cover classes needed by that program.

A Landsat TM mosaic and a modified Anderson Level 1 classification of the Willamette Valley in Oregon was delivered to the Water Resources Division NAWQA Study Site team for use in modeling and evaluation of water pollution sources and potential mitigation strategies for pollution reduction. (figure 7)

*Arctic Land
Processes Studies*

EDC scientists, in collaboration with U.S. Environmental Protection Agency (EPA), and with the support of Federal land management agencies in Alaska, produced and published a map with descriptions of the ecoregions in Alaska. This work was performed in support of the USGS Global Change Research Program for Arctic ecosystems.

The map and descriptions of 20 ecological regions were derived by synthesizing information on the geographic distribution of environmental factors such as climate, terrain, soils, vegetation, geology, geomorphology, and land use. This synthesis was a qualitative assessment of the distributional patterns and relative importance of these factors for influencing the character of the landscape from place to place.

The Alaska ecoregion map and descriptions provide an ecological framework to help integrate efforts among different interest groups and agencies. The Alaska Ecoregions map (figure 8) itself is unique and innovative. Photographs of each ecological region in Alaska accompany the descriptions of the map, giving the reader a clear visual sense of the typical landscape characteristics of the region. An accompanying table lists the major environmental characteristics occurring in each region for seven primary ecological variables.

These ecoregions will be used in research to summarize and extrapolate scientific data across and between the ecological units. Land management agencies will also use the ecological framework to assist them in adopting a more ecologically based approach to their land stewardship responsibilities.

EDC's Alaska Field Office (AFO), has continued its investigations into the impacts of global climate change in arctic ecosystems through cooperative programs with the National Park Service (NPS) and the National Biological Service (NBS). For example, land characterization data sets emphasizing vegetation mapping were initiated for the Bering Land Bridge and Noatak National Preserves for the NPS. NBS cooperative studies focused on caribou habitat assessment in the Arctic National Wildlife Refuge, and waterfowl habitat assessment in the Izembek National Wildlife Refuge. These land characterization data bases will serve as baselines for monitoring changes over the next ten to twenty years.

AFO staff continue to work on the Conservation of Arctic Flora and Fauna (CAFF) initiative supported by the U.S. Department of State and the U.S. Fish and Wildlife Service. CAFF has an objective of producing a circumpolar vegetation map for all Arctic nations to be used in their assessment of issues related to biodiversity in the Arctic. The AFO is supporting this effort with remote sensing and GIS data products.

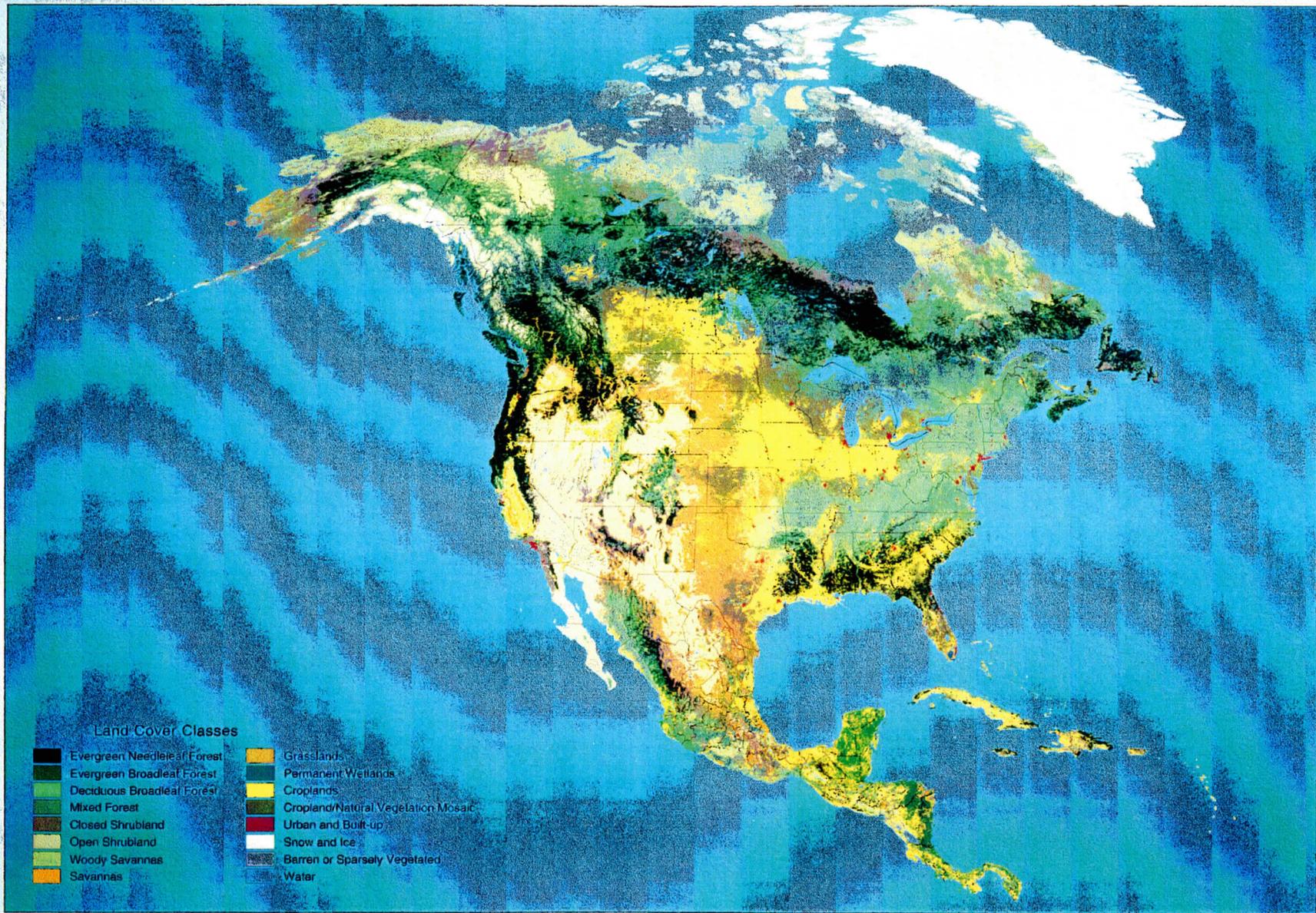
*North American
Landscape
Characterization
Project*

The North American Landscape Characterization (NALC) project, a cooperative effort between the USGS and EPA, is assembling three decades of georeferenced Landsat multispectral scanner (MSS) data for the conterminous United States and Mexico. The datasets, called triplicates, will play an important role



Figure 5

International Geosphere Biosphere Programme Global Land Cover Classification



EROS Data Center
National Mapping Division
U.S. Geological Survey
and
University of Nebraska-Lincoln



500 0 500 10 000 20,000 Kilometers
500 0 500 10,000 Statute Miles

This land cover map is based on the International Geosphere Biosphere Programme Fast-Track Global Land Cover legend. The 16 land cover classes on the map represent the regional vegetation types and mosaics that occur at the 1-km resolution.

Figure 6

*Willamette Valley, Oregon
Landsat TM Composite*

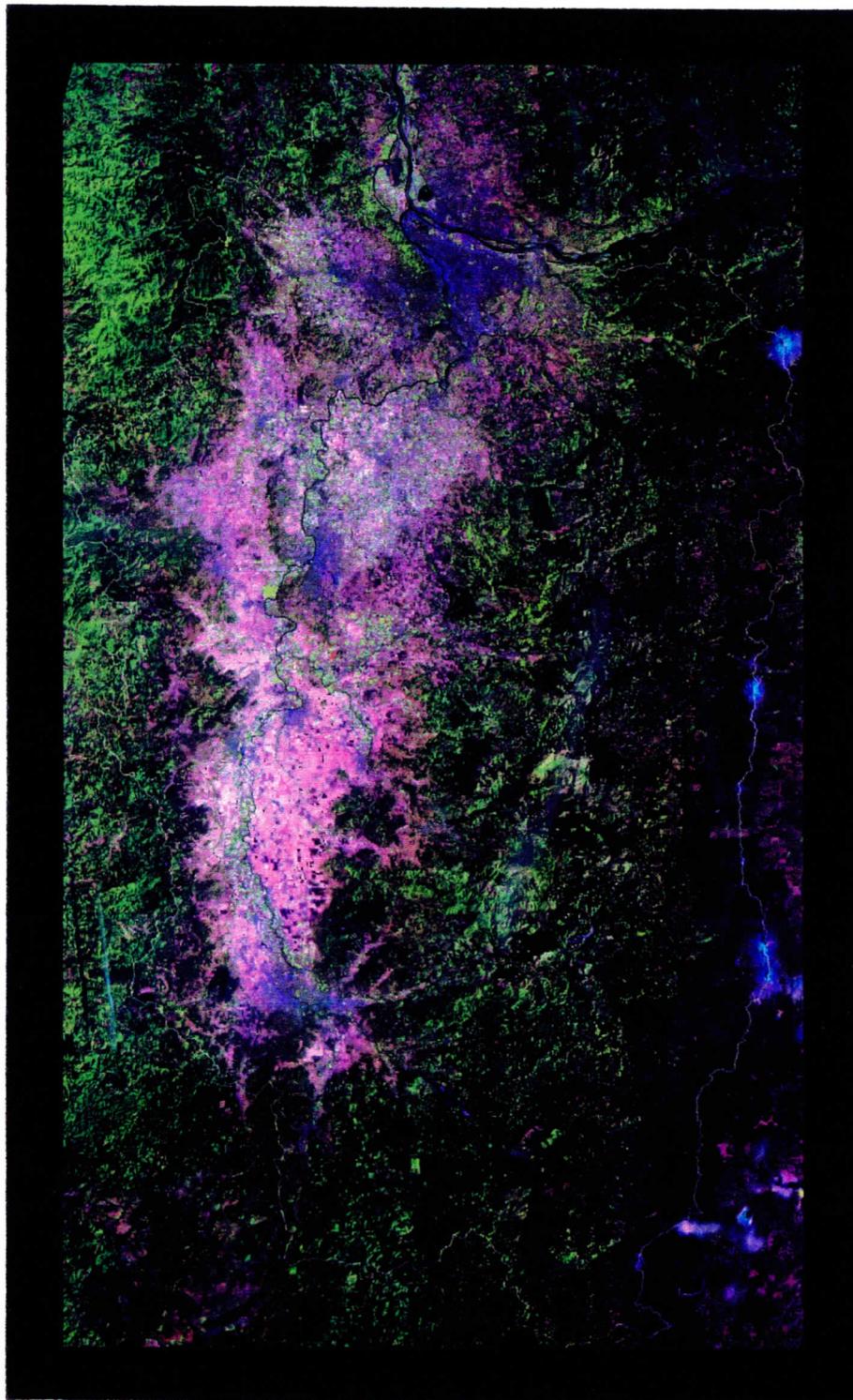


Figure 7

ECOREGIONS OF ALASKA

By Alisa L. Gallant¹, Emily F. Binnian², James M. Omernik³, and Mark B. Shasby⁴
1995

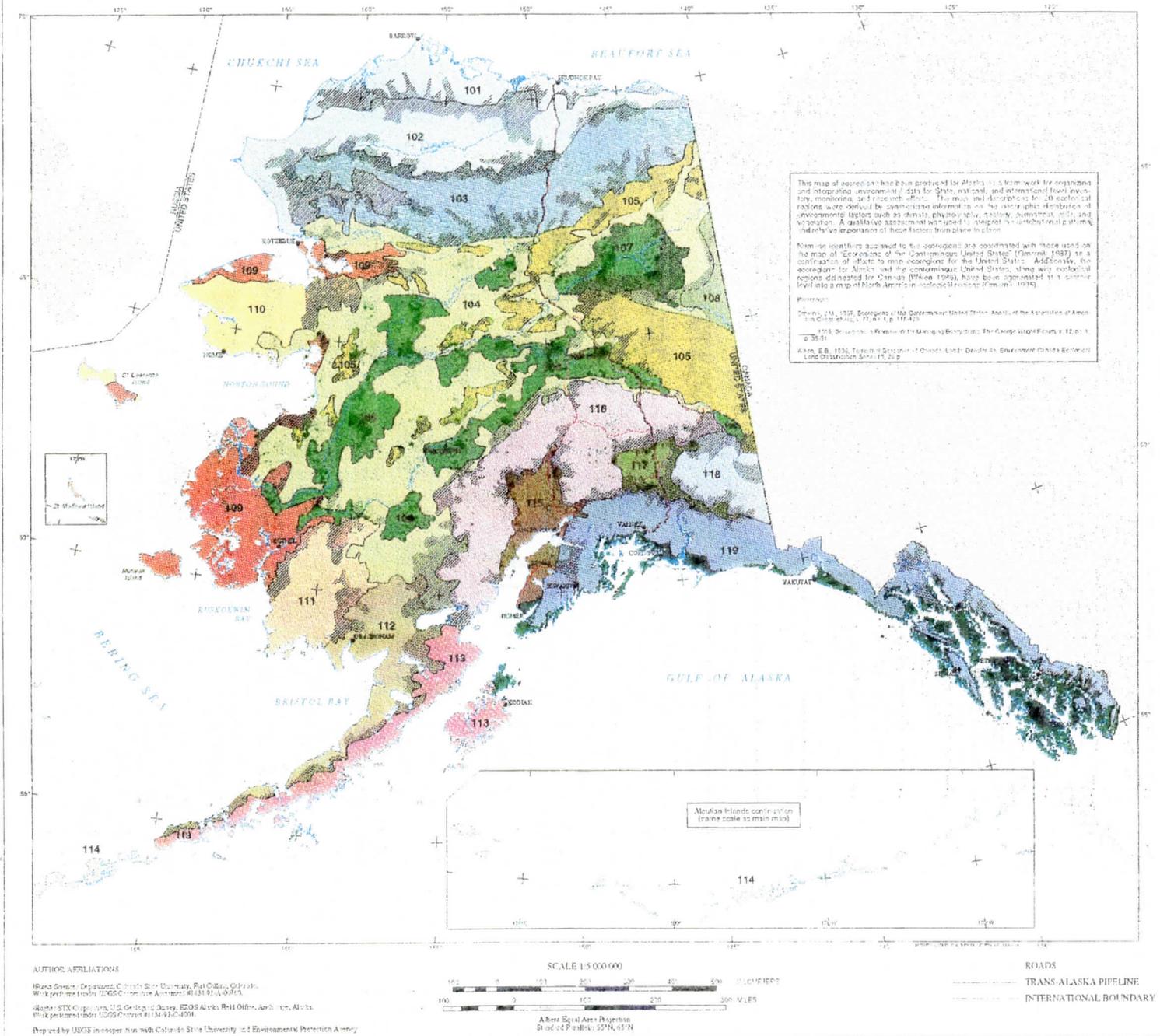


Figure 8

in evaluations of natural processes, surface characteristics, and surface changes. The data are currently being used by government agencies, educational institutions, and private industry for a variety of applications, including land cover change analysis, biodiversity fluctuations, climatic modeling, deforestation monitoring, and analysis of urban sprawl. Processing of the Landsat MSS triplicate data set was completed for 368 path/rows (185 remain to be done).

The Global Land Information System (GLIS) contains an overview of the NALC project, the processing and product documentation, the production status map, and a list of the path/rows for which triplicates are completed. The same information is available on the Internet through the World Wide Web. Subscenes for the Lake Tahoe-Reno area are presented, and a set of sample products may be retrieved via ANONYMOUS FTP. These access points were established as part of an active public outreach for the Landsat Pathfinder Program.

Urbanization has been described as a massive unplanned global experiment affecting increasingly large acreages of the Earth's surface. This massive change in land surface characteristics is just beginning to be studied by Earth systems scientists in terms of ecological processes, atmospheric implication, and micro- and macro-climatic impacts. A collaborative testbed for the Baltimore-Washington region has been designed to meet many of these integrated environmental modeling challenges. Building on research documenting urban development in the San Francisco Bay Area, EDC researchers are using historic maps, recent aerial photography and spatial data sets to map the extent of urbanization in the Baltimore - Washington Urban Corridor.

*Human Induced
Land
Transformation:
Baltimore -
Washington Urban
Corridor*

EDC staff worked with the University of Maryland Baltimore County, the Bureau of the Census, University of California at Santa Barbara, and the Goddard Space Flight Center to develop this database. The data and techniques developed in this project will be used to support research in land transformation processes by global change scientists and environmental modelers, and in the calibration, verification, and validation of temporal, thematic, and spectral models. (figure 9)

Mapping and Information Science

Gap Analysis is a nationwide U. S. Department of the Interior program to identify and map the diversity of terrestrial animal species habitats. Gaps are lands with significant species habitats that are unprotected by parks, reserves, or refuges. The Gap Analysis Program provides information to aid the process of natural resource planning and habitat management.

*Utah GAP Analysis
Project*

Working with the USGS Mapping Applications Center in Reston, Virginia and with the National Biological Service (NBS) and College of Natural Resources at Utah State University, EDC staff developed a prototype package of four maps in support of the Gap Analysis Project in Utah. The maps, at a scale of 1:750,000, include a Landsat Thematic Mapper image map, Vegetation Cover, Land Ownership and Administration, and Biodiversity Management Status. Delivery of data for all maps was completed in December, 1994; the maps were published in February, 1995.

*The Scientific
Assessment and
Strategy Team
Legacy*

During completion of the initial phase of the Scientific Assessment and Strategy Team (SAST) research that was conducted (and reported on) in FY 1994, it was realized that the large volume of geographically referenced data which was assembled would provide a long-term reference for diverse environmental studies in the region. In an effort to make the data and information compiled and derived by the SAST more widely accessible, a "clearinghouse" was developed that provides an on-line window into the SAST database – its content, selected applications, and linkages – as well as an interactive system to electronically display, select, and transfer datasets of interest directly to the user.

Primary access to the database is through the Internet using the Mosaic browser, which can access data via the World Wide Web. This allows immediate access to the most current versions of the individual data layers (more than 80 themes are currently available) and associated documentation, such as spatial metadata and related publications. Mosaic users can access and download SAST data, free of charge, from the following URL:

<http://edcwww2.cr.usgs.gov/sast-home.html>

In FY 1996, the Global Land Information System (GLIS) will enable users, who do not have Internet access or would like to have data on an off-line media, to select and order SAST data sets, at nominal cost, on CD-ROMs.

Data maintenance, management, and distribution primarily uses the distributed clearinghouse model. The SAST clearinghouse serves as a prototype for the Federal Geographic Data Committee and helps promote the National Spatial Data Infrastructure (NSDI) and the National Information Infrastructure (NII). The EDC provides the central node of the clearinghouse and other Federal, State, local, and tribal governments and nongovernment organizations provide peripheral nodes. Each node has the responsibility for maintaining its own data and distributing it to the user community. The EDC assists affiliated organizations in designing mechanisms to meet quality assurance, documentation, data comparability, and distribution requirements.

Urbanization in the Baltimore - Washington Corridor

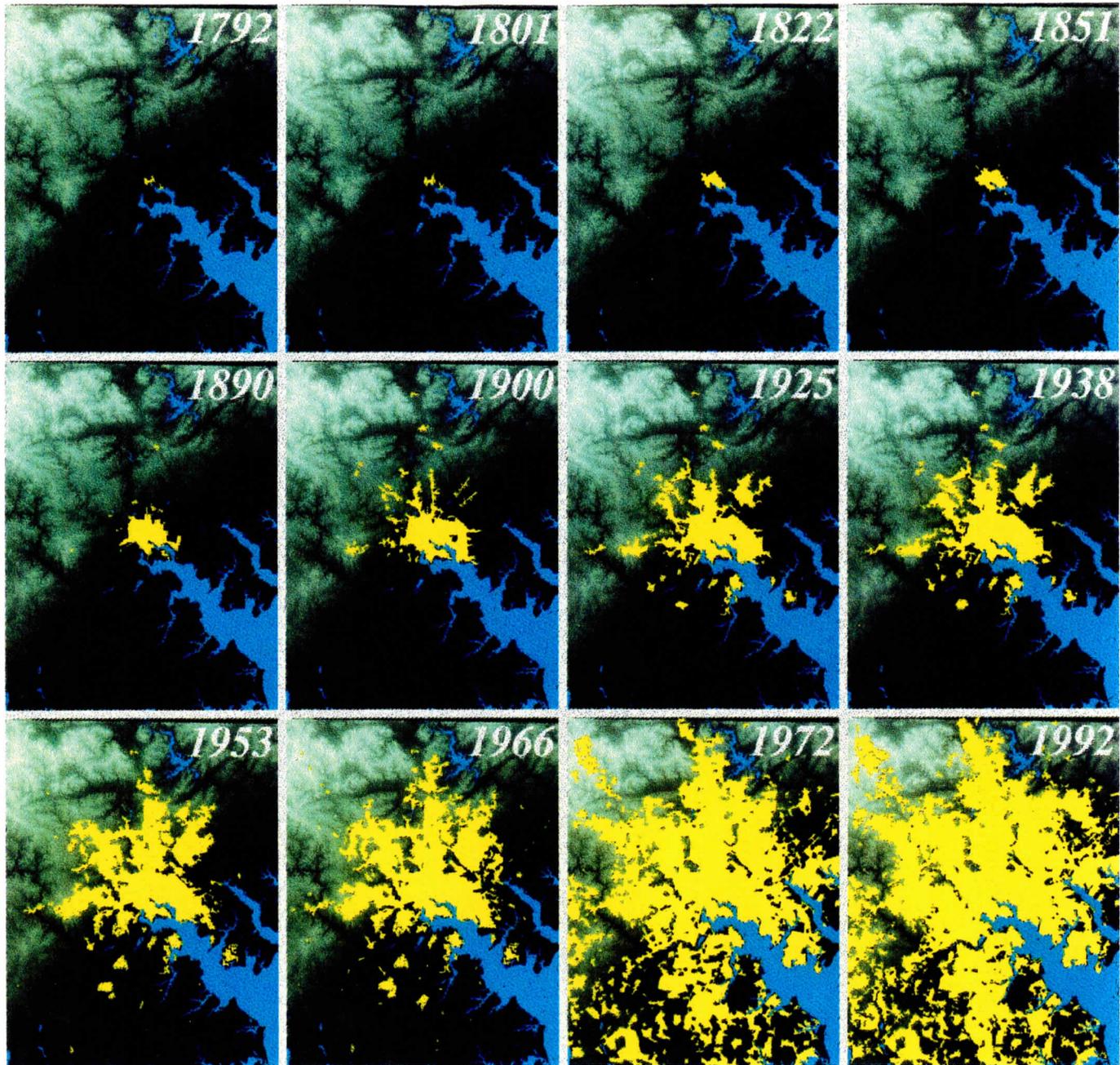


Figure 9

International Program

The International Program consists of a variety of projects involving the application of geospatial technology to problems of sustainable development and humanitarian assistance. Most projects are carried out under agreements with missions and offices of the U.S. Agency for International Development (USAID). There is increasing recognition of the value of geospatial information for planning, implementing, and assessing the impact of disaster relief and development assistance, and the instructive role it can play in revealing linkages between activities occurring in multiple sectors (agriculture, environment, population/health, transportation, education, commerce) of a developing country.

The USGS has supported the USAID Famine Early Warning System (FEWS) project with expertise and technical assistance in the use of remote sensing and geographic information systems since 1987. This support has included the creation of a significant archive of satellite image products, GIS coverages, agricultural statistics, and rainfall data used in the assessment of famine vulnerability in sub-Saharan Africa. These data have been collected and prepared by all FEWS partner organizations: Associates in Rural Development (ARD), NASA Goddard Space Flight Center, NOAA Climate Prediction Center, and USGS. In order to facilitate the distribution and utilization of data from the FEWS archive, the USGS has developed a World Wide Web (WWW) information server called the African Data Dissemination Service (ADDS). The ADDS server may be accessed with the URL:

*Famine Early
Warning System
(FEWS)*

<http://edcintl.cr.usgs.gov/adds/adds.html>

The ADDS server is populated with data collected for the Sahel and Southern Africa, and provides user access to updated AVHRR NDVI data covering all of Africa every ten days. Optionally, users may download digital files of historical rainfall data, agricultural production data, and a variety of maps including administrative boundaries and country specific information such as soils data and transportation networks. These data sets provide a means of incorporating additional context to the analysis of specific famine events, thus improving forecasting techniques.

USGS contributions to FEWS include software development for desktop data managers for tabular rainfall, agricultural production, and price data, which are also available from ADDS. Investigations of improved time-series analysis techniques to exploit NASA's 1982 to present vegetation index image data set for Africa are also carried out.

The USAID program in Madagascar places an emphasis on the conservation of the many unique species of plants and animals which have evolved on the island. In this context, the USGS provides technical support to Madagascar's National Association for the Management of Protected Areas, ANGAP. In FY

*Madagascar
Protected Areas
Management
Technical Support*

1995, procurement, delivery, and installation of GIS-related hardware and software, and associated training of ANGAP staff, continued. Assistance was provided in obtaining basic data sets, for example satellite image coverage of select national parks, digital elevation models, and preparation of specifications for contracted digitizing services. Non-Governmental Organizations (NGOs), like the World Wildlife Fund, Wildlife Conservation Society, CARE International, and Conservation International, were also supported in carrying out their work in specific protected areas. Assistance of this kind contributed to the GIS analyses of the Stanford University Center for Conservation Biology for developing proposed boundaries for the National park on the Masoala peninsula, Madagascar. (figure 10)

A need for national coverage with base category digital data was identified for nearly all projects in the USAID portfolio, not just conservation of biodiversity. Consequently, an agreement was made between the mapping agency of Madagascar (FTM), USAID/Madagascar, and USGS to have the country's 1:500,000-scale topographic maps digitized through a contract administered by the Rocky Mountain Mapping Center. The resulting national coverage, to be available in mid-1996, will provide FTM with a general purpose digital product that is superior to the Digital Chart of the World, the only national coverage currently available.

*Long-term
Monitoring of
Environmental
Change in Senegal*

There is considerable evidence of land degradation throughout Africa, driven by the interplay of changing natural processes and unprecedented human pressures. The present study focuses on Senegal, a West African country in the Sahel region. Buffeted by drought, economic hardship, and rapid population growth, Senegal's ecosystems are coming under increasing pressure. In response, the USGS in partnership with the USAID, is developing a long-term monitoring framework for understanding the rapid changes occurring in Senegal's environment. The framework will be applicable to the Sahel and other parts of the world, including the United States. The monitoring approach integrates the combined strengths of data collection at hundreds of field sites (established in an earlier USAID project in 1982-84, and revisited by EDC scientists), aerial videography, and satellite remote sensing. Local socioeconomic studies and interviews with rural people add a further dimension, a critical element for better explaining the human dimensions of change.

Many natural resource changes have occurred in Senegal since the collection of the original baseline data. The most striking of these, observed during the two major field campaigns conducted in FY95, are: the depletion of Senegal's southern woodlands, a result of local production of charcoal, land degradation on upland plateaus related to overgrazing and subsequent soil erosion, high tree mortality from long-term drought, and the expansion of areas under cultivation caused by increasing rural populations. However, the study is also highlighting numerous cases in which local people are successfully conserving and managing natural resources, including the protection of trees that enhance soil fertility, reforestation, and the use of live hedges to slow erosion. This information is

Masoala Peninsula, Madagascar

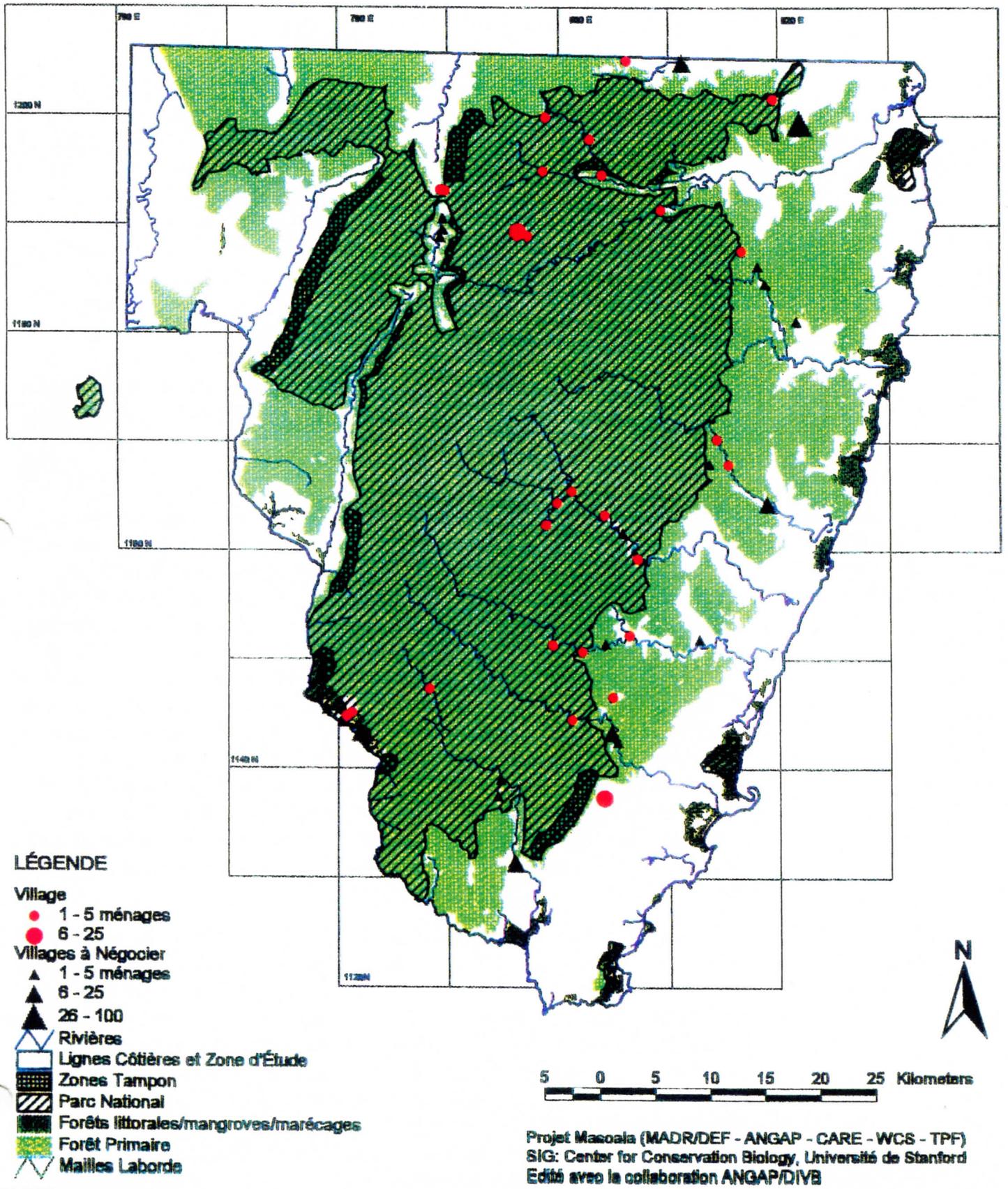


Figure 10

helping the Government of Senegal formulate better environmental policies and be proactive toward managing natural resources.

During the past year, particular emphasis was placed on the development of an aerial videography system to archive and analyze the wealth of data collected in 1994. The video data will serve as a permanent record of biophysical conditions and land use practices throughout Senegal. Flown repetitively with the aid of GPS technology, the videography represents the basis for future aerial missions to monitor environmental change at a large scale. A video tape recorder/PC system for rapid browse, retrieval, frame grabbing, analysis, and image processing was developed, and is a part of the program's technology transfer efforts to counterpart scientists at the Ecological Monitoring Center in Dakar.

The EDC staff provided technical assistance in data management and produced maps for the USAID Mission to Zimbabwe. The objective of this project is to improve USAID/Zimbabwe's tools for monitoring, evaluating, and reporting on U.S. government-funded development activities in Zimbabwe. EDC's products include a hypertext system to present briefings and obtain more detailed information about Zimbabwe and USAID/Zimbabwe's development program graphs. In addition, EDC produced satellite image maps of Zimbabwe and the Southern African Development Community (SADC). Copies of the SADC map were also requested by the White House and were used by Vice President Gore and Secretary Babbitt on their 1995 trip to Southern Africa. The EDC designed and processed digital data for two copies of a twenty-four-page, 19"x27" atlas of Zimbabwe and the Southern African Development Community for use by the U.S. Embassy to Zimbabwe and USAID/Zimbabwe. In addition, the EDC procured hardware and software and trained the Mission's Zimbabwean Program Assistant in the use of this equipment to manage the Mission's data and modify and maintain its hypertext documents.

*USAID/Zimbabwe
Mission Information
System*

Since winning its independence from Portugal in 1975, Mozambique has been plagued by economic hardships, guerilla warfare, and drought. Following the signing of the Rome Peace Accord in October 1992, and the end of the devastating region-wide drought, Mozambican refugees have been returning to rebuild their country. In 1993, the USAID instituted an innovative program to provide food and immediate assistance to returnees, to rehabilitate the transportation infrastructure, and to reestablish the agricultural economy. To evaluate the effectiveness of this strategy, the USAID contacted the USGS to develop and implement a pilot study that uses satellite imagery for documenting the return of Mozambicans to the countryside. Based on techniques originally developed for USAID's FEWS Project, Cropland Use Intensity (CUI) categories were selected for use as satellite-data-based surrogate measures of rural population density. CUI interpretations of Landsat Multispectral Scanner (MSS), Thematic Mapper (TM), and SPOT imagery were then studied to evaluate conditions in the area around the towns of Mutarara and Sena near the Zambezi River for the years 1973, 1985, 1992, 1994, and 1995.

*Monitoring
Cropland Use
Intensity in
Mozambique*

The CUI interpretations of satellite imagery chronicle the dramatic differences in utilization of land for agriculture during this politically and culturally dynamic twenty-two year period. The nearly complete elimination of crop production in this region during the war, and the subsequent recovery and expansion of agriculture due in part to assistance provided by USAID and other donors since the Accord, has been accurately documented by this approach.

*Enhancement of
Geographic
Information
Infrastructure in
Latin America*

Late in FY95, an interagency agreement with USAID's Bureau for Latin America and the Caribbean was signed, calling for efforts to enhance the geographic information infrastructure of the region. A plan was elaborated whereby the concepts and technology of the National Spatial Data Infrastructure will be introduced and applied to bring together producers and users of geospatial data throughout the hemisphere. In this way, internet communications will be exploited to increase the awareness and accessibility of geospatial data of importance for commerce, education, conservation, and government administration.

UNEP/GRID

The North American node of the United Nations Environment Programme/Global Resource Information Database (UNEP/GRID), designated GRID-Sioux Falls, is located at the EDC. The broad objective of the GRID office is to assist UNEP and its partners by contributing data and information on methodology and technology that leads to better policies on environmental issues and helps advance sustainable development initiatives.

The GRID-Sioux Falls advisory committee met on June 5, 1995, in Washington, D.C., to review the activities of the past 6 months and to approve work plans for the next 6 months. A UNEP sponsored "International Expert Consultation on Spatial Hydrologic Data Bases" meeting was organized and held June 28-29, 1995, in Washington, D.C. GRID-Sioux Falls was represented at an Earth Observing Data and Information System Potential Users conference and an organizational meeting for the State Department's Earthmap program in Washington, D.C., in June of 1995.

The biennial worldwide survey of GIS and Image Processing Software systems is being revised. An electronic questionnaire was put on the World Wide Web as an alternative to the paper version of the distributed questionnaire. A client/contacts data base was created to streamline operations within the GRID office.

Staffing levels for the GRID-Sioux Falls office increased significantly in FY 95. A full time Information Scientist, funded by NASA, joined the permanent staff. A visiting scientist from Argentina began a 6 month appointment. Two graduate students, funded through an EPA fellowship, began their one year (part time) tenure. A Kenyan and a Uganda visiting scientist joined GRID-Sioux Falls for the summer. A visiting scientist from the World Wide Fund for Nature in India began a 6 month tenure. Additionally, a visiting scientist from Japan completed a one year appointment. The results of his work on deriving elevation data from AVHRR and Landsat MSS data were presented at an in-house seminar.

A preliminary 30 arc-second digital elevation model (DEM) for Eurasia has been assembled by GRID staff from the 3 arc-second digital terrain elevation data. Work has begun to fill areas of missing data using Digital Chart of the World data. Refinement and verification of the Nile River basin (as derived from the 30 arc-second DEM of Africa) is progressing well. Work continued on the South American one-kilometer Land Cover Characteristics data base.

Outreach Activities

A video for showing in the museum in the Main Interior Building in Washington, D.C. was produced in the fiscal year by the EDC's media services group. A brief video, introducing visitors to the EDC was revised to reflect changes in programs and activities during the year. Two other videos, one involving land characterization research and one describing the mission, history and products of the National Mapping Division were developed and completed in the fiscal year.

Video Production

With the continuing development of the World Wide Web home page on the Internet, the EDC's outreach activities moved to a broad based, national and international effort. Although only a small fraction of the Internet public who access the EDC's information do so through the home page, it functions as an important 'window' on USGS, NMD and EDC activities. Through that instrument, Internet viewers are able to reach the Global Land Information System, the NDCDB Sales Data Base managed by the EDC, preview newly released declassified satellite imagery, and learn a great deal of information about its activities and its parent organizations.

Internet Access

The EDC has been closed to the general public because of the building construction that will significantly increase the size of the facility. During that time, considerable planning was devoted to designing proper facilities and displays for visitors when the construction is completed. Since the EDC was closed to visitors, an expanded program of sending staff to schools and community groups was instituted. EDC personnel participated, for example, in South Dakota Space Day, several Water festivals, and in smaller programs designed to teach students and teachers about conservation management, remote sensing and cartography.

Community Outreach

One exception to the closing of EDC to visitors was participation in the USGS' "Take Your Child to Work" program. Over 90 young people spent the day at the EDC, learning about work done here and shadowing their parent.

Take Your Child to Work

Statistical Data

This section summarizes EDC sales and distribution of products and services provided in fiscal year 1995. It also provides information about customer profiles, historical trends, and the contents of the EDC archives and data bases.

Products and Services

In fiscal year 1995, EDC produced and distributed nearly \$7.7 million worth of products and services. Of the total, nearly \$3.1 million were direct repay sales and almost \$1.9 million were products and services provided through EDC cooperative repay projects, for a "reimbursable" total of almost \$5 million. The remaining \$2.7 million were for products and services distributed to users within the U.S. Geological Survey at EDC, other National Mapping Division facilities, and other divisions of the USGS.

In addition, over 1,000,000 files of digital cartographic data were distributed at no charge to the customer via the Internet. More than 100,000 user inquiries were received during the year, and over 18,000 orders were filled.

	<u>Items</u>	<u>Dollars</u>
Photographic Products.....	254,945	3,067,661
Digital Products/Processing	102,555	4,584,858
Reference Aids	71	15,078
Miscellaneous	2,978	25,453
Total	360,549	\$7,693,050

**EDC Annual Sales Report
Fiscal Year 1995**

	DIRECT REPAY CUSTOMERS	EDC REPAY PROJECTS	USGS CUSTOMERS	TOTAL
PHOTOGRAPHIC DATA				
AERIAL IMAGES				
NAPP	\$ 1,348,837	\$ 18,107	\$ 861,560	\$ 2,228,504
SLAR	6,174	2,125	950	9,249
Other	336,346	10,611	25,832	372,789
SATELLITE IMAGES				
Landsat MSS	46,762	9,606	3,856	60,224
Landsat TM	65	3,201	189	3,455
AVHRR	1,642	8,154	3,255	13,051
Other	2,992	0	0	2,992
Digital Film Recorder Products	1,540	70,575	106,495	178,610
Other Photographic Data	<u>30,013</u>	<u>64,235</u>	<u>104,539</u>	<u>198,787</u>
TOTAL PHOTOGRAPHIC DATA	\$ 1,774,371	\$ 186,614	\$ 1,106,676	\$ 3,067,661
DIGITAL DATA PRODUCTS/PROCESSING				
Digital Data Processing	\$ 16,731	\$ 756,423	\$ 1,158,556	\$ 1,931,710
SLAR Images	7,536	800	96	8,432
Landsat MSS Image Data	375,419	432,355	31,525	839,299
Landsat TM Image Data	439,775	395,605	241,087	1,076,468
AVHRR Images	83,339	36,437	104,581	224,357
*NDCDB Data	356,310	2,115	34,512	392,937
NURE Data	3,760	0	0	3,760
Other Digital Data	<u>8,864</u>	<u>85,108</u>	<u>13,924</u>	<u>107,896</u>
TOTAL DIGITAL DATA PRODUCTS/PROCESSING	\$ 1,291,734	\$ 1,708,843	\$ 1,584,281	\$ 4,584,858
MISCELLANEOUS				
Reference Aids	\$ 9,264	\$ 500	\$ 5,315	\$ 15,079
Other Products and Services	<u>21,985</u>	<u>1,031</u>	<u>2,436</u>	<u>25,453</u>
TOTAL MISCELLANEOUS	\$ 31,249	\$ 1,531	\$ 7,751	\$ 40,531
GRAND TOTAL	\$ 3,097,354	\$ 1,896,988	\$ 2,698,708	\$ 7,693,050
Satellite Data Brokerage Fees	\$ 143,877	\$ 46,236	\$ 183	\$ 190,297

* Does not include no-cost electronic distribution of data.

Product Profile
EDC Photographic Products
Fiscal Year 1995

BLACK-AND-WHITE PRODUCTS

PRODUCT CATEGORY	ITEMS	DOLLARS
10" Film/Paper	126.405	\$ 952.754
10" Diapositives	73.970	511.625
20" Paper	6.866	134.978
30" Paper	10	132
40" Paper	6.506	258.431
Other	<u>2.332</u>	44,551
TOTAL	216.089	\$ 1,902,471

COLOR PRODUCTS

PRODUCT CATEGORY	ITEMS	DOLLARS
10" Film/Paper	27.471	\$ 683.800
10" Diapositives	100	1,400
20" Paper	2,335	120,498
30" Paper	0	0
40" Paper	3,283	251,962
Other	<u>5,667</u>	<u>107,461</u>
TOTAL	38,856	\$ 1,165,190
GRAND TOTAL PRODUCTS	254,945	\$ 3,067,661

Customer Profile
EDC Photographic Products
Fiscal Year 1995

CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	149,543	\$1,293,290
OTHER FEDERAL	<u>21,183</u>	<u>328,360</u>
TOTAL FED. GOVERNMENT	170,726	\$1,621,650
STATE/LOCAL GOVERNMENT	11,013	182,933
ACADEMIA	14,574	150,643
INDUSTRY	43,258	826,510
INDIVIDUALS	13,958	264,663
NON-U.S.	<u>1,416</u>	<u>21,262</u>
TOTAL	254,945	\$3,067,661

Customer Profile
EDC Digital Data Products & Processing
Fiscal Year 1995

Digital Data Products *		
CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	16,611	\$1,378,146
OTHER FEDERAL	<u>5,065</u>	<u>124,872</u>
TOTAL FED. GOVERNMENT	21,676	\$1,503,018
STATE/LOCAL GOVERNMENT	813	15,663
ACADEMIA	5,775	153,593
INDUSTRY	32,715	534,852
INDIVIDUALS	38,850	104,735
NON-U.S.	<u>1,738</u>	<u>341,288</u>
TOTAL	101,567	\$2,653,149

* Does not include no-cost electronic distribution of data.

Digital Data Processing		
CUSTOMER CATEGORY	ITEMS	DOLLARS
USGS	985	\$1,914,978
OTHER FEDERAL	<u>1</u>	<u>15,741</u>
TOTAL FED. GOVERNMENT	986	\$1,930,719
STATE/LOCAL GOVERNMENT	1	150
ACADEMIA	0	0
INDUSTRY	1	840
INDIVIDUALS	0	0
NON-U.S.	<u>0</u>	<u>0</u>
TOTAL	988	\$1,931,709
GRAND TOTAL DIGITAL DATA PRODUCTS PROCESSING		\$4,584,858

Archives and Data Bases

This section describes those data archives, both digital and photographic, that are maintained by EDC to preserve and reference remotely sensed, cartographic, and earth science data. In addition, several databases reference data held elsewhere that are of interest to EDC customers.

As of the end of fiscal year 1995, the Data Center has archived over 10.6 million frames of photographic data and over 128,000 digital tapes. This included more than 2.8 million frames of Landsat photographic data and nearly 80,000 Landsat data tapes. The international Landsat Data Base maintained by EDC referenced over 940,000 Landsat scenes archived in the United States, and over 2.44 million scenes of Landsat data held by foreign ground stations.

Data Archive Report As of September 15, 1995

SUMMARY OF DATA ARCHIVED AT EDC

PHOTOGRAPHIC DATA	ROLLS	FRAMES
AERIAL IMAGES	56,332	7,512,252
LANDSAT SATELLITE IMAGES	21,260	2,856,047
OTHER SATELLITE IMAGES	<u>3,257</u>	<u>288,528</u>
TOTAL	80,849	10,656,827

DIGITAL DATA	MAGNETIC TAPES	SCENES/ FILES
AERIAL IMAGE DATA	4,471	7,851
LANDSAT SATELLITE IMAGE DATA	80,083	1,060,609
OTHER SATELLITE IMAGE DATA	41,981	N/A
NDCDB DATA	1,206	53,247
EARTH SCIENCE DATA	978	7,949
TOTAL	128,719	1,129,656

N/A = Information not available.

**Data Archive Report
As of September 15, 1995**

PHOTOGRAPHIC DATA ARCHIVED AT EDC

AERIAL PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
U.S. Geological Survey	17,375	2,590,065
NAPP	10,418	1,591,945
Bureau of Land Management	625	125,048
Bureau of Reclamation	301	60,343
National Park Service	85	14,551
Bureau of Indian Affairs	<u>49</u>	<u>9,913</u>
TOTAL DEPARTMENT OF THE INTERIOR	28,853	4,391,865
Army Map Service	1,681	213,995
U.S. Air Force	3,403	337,697
U.S. Navy	6,437	434,252
Corps of Engineers	<u>82</u>	<u>22,924</u>
TOTAL DEPARTMENT OF DEFENSE	11,603	1,008,850
Ames Research Center	4,727	599,331
Johnson Space Center	7,632	1,012,642
Other	<u>1,413</u>	<u>134,577</u>
TOTAL NASA	13,772	1,746,512
OTHER SOURCE AGENCIES	2,104	365,025
TOTAL AERIAL PHOTOGRAPHY	56,322	7,512,252

SATELLITE PHOTOGRAPHY		
SOURCE	ROLLS	FRAMES
Landsat MSS 70mm Film (1/2/3)	7,708	1,342,187
Landsat MSS 9" B&W Film	10,628	1,338,195
Landsat TM 9" B&W Film	2,924	175,665
Skylab	634	44,845
Apollo/Gemini/Apollo-Sojuz	127	18,372
Shuttle (Incl. LFC)	2,496	225,311
TOTAL SATELLITE PHOTOGRAPHY	24,517	3,144,575

**Data Archive Report
As of September 15, 1995**

DIGITAL DATA ARCHIVED AT EDC

SOURCE	MAGNETIC TAPES	SCENES/FILES
AERIAL IMAGE DATA		
NASA Data		
TMS / NS001	1,134	4,913
M2S 11-Channel Data	76	N/A
AOCI 10-Channel Data	44	N/A
National Park Service	94	N/A
Side-Looking Airborne Radar (SLAR)	<u>2,523</u>	<u>2,938</u>
TOTAL	4,471	7,851
SATELLITE IMAGE DATA		
Landsat MSS/TM digital Data	80,083	949,419
AVHRR		
EDC-HRPT Data	11,358	29,944
LAC Data Received via DOMSAT	12,951	43,535
LAC Data Received from Other Sources	9,237	33,284
Federally-Owned Landsat Data (FOLD)	1,224	1,224
SPOT Data	306	306
Department of Defense MSI Data	<u>6,905</u>	<u>2,897</u>
TOTAL	122,064	1,060,609
NDCDB DATA		
Digital Elevation Model (DEM)	159	35,341
1:2 Million Digital Line Graph (DLG)	8	511
1:100k DLG; 1:25k LULC; 1 DEG & 24k DEM	<u>1,039</u>	<u>17,395</u>
TOTAL	1,206	53,247
EARTH SCIENCE DATA		
National Uranium Resource Evaluation (NURE)	957	7,949
Geophysical Research Program	<u>21</u>	<u>N/A</u>
TOTAL	978	7,949
TOTAL DIGITAL HOLDINGS	128,719	1,129,656

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